CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS
MINES BRANCH

OTTAWA

FUELS AND MINING PRACTICE DIVISION

INTERNAL REPORT FMP 62/76-PRE

WORKING PARTY ON MOVEMENT OF SOLIDS

REPORT NO. 2

"PIPELINE DEVELOPMENT DISCUSSION", EDMONTON, MAY 17, 1962

by

R.P. Charbonnier

May 1962

90-04534/

"PIPELINE DEVELOPMENT DISCUSSION", EDMONTON, MAY 17, 1962

by

R.P. Charbonnier

CONTENTS

	Page
Background of the meeting	1
Purpose of the meeting	1
Participants of the meeting	2
Agenda of the meeting	7
Proceedings of the meeting	8
Agenda items No. 1 and No. 2	8
Agenda item No. 3: Brief outline of Council's pipeline research program	8
Agenda item No. 4: Pipeline transportation of coal	9
Agenda item No. 5: Pipeline transportation of packages	10
Agenda item No. 6: Discussion	11
a) Pipelining coal for power generation	11
b) Possibilities of bulk transport of grain by capsule pipeline	14
c) Pipeline's for heavy mineral products	15
d) Role of pipeline companies	15
e) Role of pipeline contractors	15
f) Role of the railways	15
g) The national point of view	16
Agenda item No. 7: Consideration of development of field studies and/or other future action	16
Concluding remarks	18

"PIPELINE DEVELOPMENT DISCUSSION"
EDMONTON, MAY 17, 1962

by

R.P. Charbonnier*

Background of the meeting:

During the last few years, the Research Council of Alberta has carried out theoretical and laboratory pipeline researches, related to wider uses of pipelines for the transportation of bulk commodities. Recent studies have been concerned with slurries of solids in liquids, and with capsules or packages in a liquid stream; and they seemed to indicate that pipelines may be able to take over in the foreseeable future a significant part of the transportation of bulk commodities. Therefore the Research Council of Alberta believes, because of the importance of transportation in the Canadian economy, that careful and serious consideration should be given at an early date to continuation and expansion of pipeline transportation studies. The research workers, now engaged on this work at the Research Council of Alberta, think that a stage has now been reached, where scale-up beyond the laboratory should be considered; however it is felt that this scale-up development should be the responsibility of industry with the cooperation of the Council in planning and scientific assistance.

Purpose of the meeting:

In order to inform them of the scope of its pipeline investigations, the Council sent, in the Winter of 1962, a summarized report to numerous representatives of industry and government agencies. This report outlined experimental work recently carried out, economic studies, and proposals of various stages, by which a comprehensive pipeline development station might be created. It was entitled "Pipeline Investigations", Edmonton, February, 1962, and the Council

---

* Senior Scientific Officer, Division of Fuels and Mining Practice, Mines Branch, Department of Mines and Technical Surveys, Ottawa, Ontario.

explained that it had been prepared with the encouragement of a number of interested industrial parties, which suggested that a comprehensive field station for pipeline experimentation would be of interest to industry.

With a view to discussing scale-up beyond the laboratory level, the Research Council of Alberta organized a "Pipeline Development Discussion" on May 17, 1962, in Edmonton, to which many representatives of industry, university and government were invited.

Participants of the meeting:

The list of participants to this meeting was as follows:

Allman, A.J.	Government of Alberta, Edmonton
Anderson, J.A.	Board of Grain Commissioners, Winnipeg
Brandt, D.R.	Trans Prairie Pipelines, Ltd.
Banister, R.K.	Fulton Banister Ltd., Edmonton
Barnes, T.C.	Canadian Wheat Board, Winnipeg
Berkowitz, N.	Research Council of Alberta, Edmonton
Blades, A.T.	Research Council of Alberta, Edmonton
Bolt, L.H.	Research Council of Alberta, Edmonton
Booth	Pembina Pipeline Company, Calgary
Bork, G.K.	Alberta Phoenix Tube and Pipe Ltd., Edmonton
Brese, W.G.	Dept. of Industry and Development, Edmonton
Broughton, O.J.	Alberta Wheat Pool, Calgary
Brown, G.E.	Pembina Pipeline Company, Calgary
Bullymore, G.W.	Dept. of Mines and Minerals, Edmonton

Carlistle, C.	Imperial Pipe Line Co., Limited, Edmonton
Charbonnier, R.P.	Dept. of Mines and Tech. Surveys, Ottawa
Charles, M.	University of Alberta, Edmonton
Charlesworth, J.S.	Research Council of Alberta, Edmonton
Christian, E.W.	Imperial Pipeline Company, Edmonton
Clark, K.A.	Research Council of Alberta, Edmonton
Connelly, E.	Pembina Pipeline Company, Calgary
Cullimore, P.J.	Luscar Coals Ltd., Edmonton
Diskin, J.S.	Coleman Collieries Limited, Coleman, Alta.
Drum, I.M.	Home Oil Co. Ltd., Calgary
Elliott, D.R.	Pulp and Paper Institute, Montreal
Ellis, H.	Research Council of Alberta, Edmonton
Elofson, R.M.	Research Council of Alberta, Edmonton
Evans, R.A.	Canadian National Railways, Montreal
Fuller, E.A.	Britamoil Pipeline Co., Toronto
Gainer, W.	University of Alberta, Edmonton
Gishler, P.E.	Canadian Chemical Co., Ltd., Edmonton
Godard, R.M.	Steel Company of Canada Ltd.
Govier, G.W.	University of Alberta, Edmonton
Gravenor, C.P.	Research Council of Alberta, Edmonton
Gregory, J.	Research Council of Alberta, Edmonton

Hagbood, H.W.	Research Council of Alberta, Edmonton
Harquail, F.J.	Coleman Collieries Limited, Coleman, Alta.
Harries, H.	University of Alberta, Edmonton
Heffernan, G.	Peace River Mining and Smelting Co., Ltd., Edmonton
Heiner, C.P.	Coleman Collieries Limited, Coleman, Alta.
Heule, R.K.	Interprovincial Pipeline Co. Ltd., Toronto
Hnatyshyn, A.	Century Coals Ltd., Drumheller, Alta.
Hodgson, G.W.	Research Council of Alberta, Edmonton
Jackson, W.B.	Canadian National Railways, Edmonton
Jenkinson, R.M.	Luscar Coals Ltd., Edmonton
Jensen, E.R.	Research Council of Alberta, Edmonton
Johnston, T.S.	Interprovincial Pipeline Company Ltd., Toronto
Jones, A.B.	Interprovincial Pipeline Company Ltd., Toronto
Jones, H.R.	Canadian National Railways, Edmonton
Lang, W.A.	Research Council of Alberta, Edmonton
Larson, F.H.	Canadian Industrial Gas Ltd., Edmonton
Livingstone, R.E.	Lethbridge Collieries Ltd., Lethbridge
Lovington, R.C.	Canadian Bechtel Ltd., Toronto

MacGregor, J. G.	Alberta Power Commission, Edmonton
Mahoney, E.	Canadian Bechtel Ltd., Toronto
Mansfield, R.J.	Research Council of Alberta, Edmonton
McDermott, S.W.	Premier Steel Co. Ltd., Edmonton
McIntosh, D.S.	Trans-Prairie Pipelines Ltd., Edmonton
McMullen, S.G.	Amalgamated Coals, Drumheller, Alta.
Mims, J.E.	Shell Oil Company of Canada, Toronto
Moreland, C.	Research Council of Alberta, Edmonton
Newton, R.	Research Council of Alberta, Edmonton
Oberholtzer, J.E.	Chairman of the Pipeline Development Discussion, Dept. of Industry and Development, Edmonton
O'Brian, C.L.	Chairman, Dominion Coal Board, Ottawa
Parkinson, F.E.	Lasalle Hydraulic Lab. Ltd., Lasalle, P.Q.
Patrick, O.	Century Coals Ltd., Drumheller, Alta.
Patterson, G.	Buckeye Pipeline Co., New York
Paul, R.	Canadian Bechtel Ltd., Toronto
Quilley, C.H.	Canadian National Railways, Edmonton
Redberger, P.J.	Research Council of Alberta, Edmonton
Hon. Reierson, R.	Government of Alberta
Ritchie, R.P.	Shell Oil Company of Canada, Toronto
Robinson, A.P.	Inland Cement Co. Ltd., Edmonton

Roehl, A.	Research Council of Alberta, Edmonton
Romoff, H.M.	Canadian Pacific Railway Co., Montreal
Royer, M.	National Energy Board, Ottawa
Ryan, G.E.	Calgary
Seibert, F.V.	Edmonton
Shackson, R.H.	New York Central System, Cleveland, Ohio
Snyder, D.	Banister Construction Co., Edmonton
Steinbock, R.H.	Alberta Phoenix Tube and Pipe Ltd., Edmonton
Swanson, A.G.	Alberta Phoenix Tube and Pipe Ltd., Edmonton
Thomson, J.G.	Imperial Oil Ltd., Calgary
Turner, D.E.V.	Canadian Industries Ltd., Edmonton
Turner, S.D.	Big Inch Pipe Corporation Ltd., Calgary
Waist, H.F.	Canadian Bechtel Ltd., Toronto
Wenaas, C.J.	Economic Advisory and Planning Board, Regina
Whittaker, W.C.	Coal Operators Association of Western Canada, Calgary
Williams, J.C.	Canadian Pacific Railway Co., Montreal
Wilson, E.D.	Imperial Oil Ltd., Calgary
Wilton, G.	Mid-Continent Pipelines Ltd., Toronto
Winning, M.	Shell Oil Co., Calgary
Wissinger, R.E.	Alberta Phoenix Tube and Pipe Ltd., Edmonton
Wood, J.C.	Research Council of Alberta, Edmonton

Agenda of the meeting:

The following agenda was adopted for the meeting which was under the chairmanship of Mr. J.E. Oberholtzer, Deputy Minister of Industry and Development, Edmonton:

AGENDA

1.	Chairman's Remarks	J.E. Oberholtzer
1a.	Hon. R. Reierson: Welcome Speech	
2.	Greetings from the Province of Alberta.	The Hon. A.R. Patrick, Chairman Research Council of Alberta, Minister of Industry and Development
2a.	W.A. Lang: Notes on the activities of the Research Council of Alberta. Desirability and possibility of scale-up investigations.	
3.	Brief Outline of Council's pipeline research program.	H.W. Habgood, Chief, Fuels Branch
4.	Pipeline transportation of coal. Comments on laboratory studies and possible application.	N. Berkowitz, Head, Coal Division
5.	Pipeline transportation of packages. Comments on laboratory studies and on the general economics of capsule transport.	G.W. Hodgson, Head, Petroleum Division.

6. Discussion:

   (a) Pipelining coal for power generation
   (b) Possibilities of bulk transport of grain by capsule pipeline
   (c) Pipelines for heavy mineral products
   (d) Role of pipeline companies
   (e) Role of pipeline contractors
   (f) Role of the railways
   (g) The national point of view

7. Considerations of development of field studies and/or other future action.

8. After dinner: demonstration of RCA pipeline laboratory installations in operation.

Proceedings of the meeting:

The Chairman stated that the "Pipeline Development Discussion" would be tape-recorded, quickly printed and later made available to the participants. Therefore this report is limited to a brief summary of the main phases of the Discussion.

Agenda items 1 and 2:

After the Chairman's remarks, outlining the background and purposes of the meeting, as indicated above, The Hon. R. Reierson presented greetings from the Government of Alberta. Then Mr. W.A. Lang, Acting Director of the Research Council of Alberta, gave a brief outline of the history and activities of the Council, finally emphasizing the desirability of scale-up investigations by industry to continue and apply the research work of the Council.

Agenda item 3: Brief outline of Council's pipeline research program, by Dr. H.W. Habgood, Chief, Fuels Branch, Research Council of Alberta.

This program started in cooperation with the University of Alberta (Dr. G.W. Govier and graduate students working for M. Sc. degrees). The first studies investigated the possibility of using a water film to facilitate the flow of highly viscous oils in pipelines. It included both theoretical and experimental studies on the flow of two immiscible liquids. This led to investigations on the flow of separate plane layers of liquids, and on concentric patterns of flow, first with a center core of oil surrounded by a water film, and later with a center core of bubbles or "slugs" surrounded by oil.

Eventually the study of slugs of solid particles led to the consideration of "capsules" as a means of transportation of solids in a pipeline.

Dr. Habgood also mentioned the use of operations research methods to examine the interactions of competing sources of supply of fuels in the Canadian market, and the possible impact of technological advances in transportation methods.

The pumping in pipelines of very high density liquids and slurries has also been considered by the Council, but it was felt that this type of research might be left to other organizations, which are already more active in this field.

Studies of pipeline transportation of coal in oil rather than water were favoured, because of the improvement in the costs of moving a valuable carrier fluid rather than worthless water, and also because some oil pipelines were already built. "External" separation of coal and oil (by distillation) has appeared more expensive than non-thermal separation (by cyclones and solvent extraction), which is therefore preferred at present.

Dr. Habgood finally stated that scale-up investigations seem desirable technically at least, and referred to the proposals given on pages 29 to 31 of the Council's "Pipeline Investigations".

Agenda item 4: Pipeline transportation of coal. Comments on laboratory studies and possible application, by Dr. N. Berkowitz, Head, Coal Division, Research Council of Alberta.

Pilot plant investigations have shown that the pipeline transportation of a coal-in-oil slurry is technically possible. The latest development in the Council's research is a bench scale model of transportation in an oil pipeline of slugs of a slurry of coal-in-water. Then the separation of the slugs from the oil is obtained by simple and cheap screening only. This project will be set up on a pilot plant scale in a few weeks under Dr. C. Moreland's supervision, and may be ready for the industrial scale-up stage next year.

Dr. Berkowitz stated that the main weakness of the Council's economic studies was in the estimates of future market size. For instance, the market requirements appear to be lower than shown on page 15 of "Pipeline Investigations" and only one thermal station is now expected to be sufficient during the period considered. Freight rates also may change, but 1/2 cent/ton/mile is already close to the minimum possible for railways. With new sources of energy and technological developments, it is possible that long distance coal pipelines would be obsolete before they become feasible.

In conclusion of his summary of the Council's work on coal pipelines, Dr. Berkowitz suggested that the new pipeline across Canada to Montreal, recently proposed by the Prime Minister, Mr. J. Diefenbaker, could be installed with facilities suitable for the transportation of many solid products from Western Canada. Thus, scale-up investigations would be urgently desirable.

Agenda item 5: Pipeline transportation of packages. Comments on laboratory studies and on the general economics of capsule transport, by Dr. G.W. Hodgson, Head, Petroleum Division, Research Council of Alberta.

Dr. Hodgson first emphasized the need for an economic evaluation at each stage of a project after the concept study (when only ideas are involved), after the scientific study (including literature surveys and laboratory or small pilot plant investigations) and after the technology (scale-up development) to finally reach commercial applications.

The Council's fluid flow investigations began about 1948 with two-phase flow studies related to Dr. Govier's work on liquids and gases. This led to heat transfer studies, and eventually to research on the flow of slurries such as sand-in-water in 1950, and later coal-in-oil (with thermal separation) and also nickel-in-water.

Dr. Hodgson then gave a summary of the "capsule flow" section of "Pipeline investigations". Estimates of some characteristics of proposed pipelines transporting solids were given as follows:

Type of pipeline	Dense Slurry	Grain Capsules	Sulphur Capsules	Cannon ball
Throughput (in MM tons/ year)	1	10	2	1
Pipe diameter (inches)	8	30	10	8
Pipe length (miles)	50	1025	1400	600
Capital cost ($ millions)	1.46	107.5	630	27.7
Costs: $/ ton/ mile				
" Capital	0.72	0.19	0.37	0.69
" Maintenance	0.05	0.01	0.02	0.05
" Operating	0.40	0.07	0.24	0.16
" Packaging	-	0.25	0.02	-
" TOTAL	1.17	0.52	0.65	0.90
" Competing Transportation	1.50	0.50	0.80	1.50

The estimates for "cannon ball" or slug operations are based on the assumption that the pipeline would be loaded at 15% of solids. These figures would be improved by loading the pipeline up to 45% solids, which seems technically possible.

Finally, Dr. Hodgson stated that the Council's expenditures up to the present have been about $150,000, and he indicated that the technology or scale-up phase now contemplated may cost 1/2 to one million dollars, and eventually the commercial applications may cost 50 to 500 million dollars.

Agenda item 6: DISCUSSION

a) Pipelining coal for power generation

Mr. F.J. Harquail asked whether capsule transportation of coal was considered, and Dr. Berkowitz answered that the present coal studies have been limited to the case of slurries.

Mr. A. Hnatyshyn wondered about the financing of further investigations by provincial or federal government agencies, and the Chairman considered the question somewhat premature and postponed it until the last items of the agenda.

Mr. C.L. O'Brian summarized the general attitude of the Dominion Coal Board, which carefully investigates on the possibilities of any development, that may improve the situation of the Canadian coal industry, and then advises the federal government according to its findings. Although the Chairman of the Dominion Coal Board emphasized the bright long term future possibilities of transporting coal in very large amounts for power generation, which might be favoured by the use of pipelines, he was pessimistic regarding the near future of coal-in-oil pipelines for long distances, and saw better potentialities in the not too distant future for coal-in-water pipelines, similar to the present installation and projects in the USA, which serve specific requirements from the supplier to the consumer. Mr. O'Brian mentioned many important factors, which must be seriously considered, such as the varieties of coal, the large economical size of the consumer markets required, the large stockpile protection needed for thermal coal plants, etc., and thus he wondered whether the time was ripe for scale-up investigations.

Mr. F.J. Harquail gave some data from a study of a 12-mile coal-in-water pipeline project prepared by an experienced U.S. firm for the Coleman Collieries. With a 12 inch pipeline, it was found that O-1/4" was the optimum practical size for the coal in a $675,000 pipeline, using a maximum of 38% by volume of coal in the water. In order to move a O-1/2" coal with a maximum of 22% of coal in the water slurry, it would be necessary to install a $1,170,000 pipeline. Finally the transportation of a O-3/4" coal would be definitely uneconomical compared to the truck haulage costs of $0.90/ton (the loads are going downhill practically all the way).

It was then mentioned that the Cleveland coal in water pipeline transports coal, which has been crushed to 14 mesh, on a distance of 108 miles, thereby saving about 5% of the total costs of the coal for the consumer.

Coking properties of the coal were said to be generally better protected by crushing coal under water.

Mr. W.C. Whittaker reviewed some of the main characteristics of the coal-in-water Cleveland pipeline, the gilsonite-in-water pipeline in Utah-Colorado, and the new coal in water pipeline project of the Consolidated Coal Company from West Virginia to the Atlantic coast. It would appear that coal could be moved from Utah to California for approximately $3.75/ton instead of over $5 by railway. The reduction expected by Consolidated Coal Co., on the East Coast is in the order of $1/ton, cheaper than by rail.

Mr. J.G. MacGregor, of the Alberta Power Commission, mentioned, in connection with the recent provincial-federal meeting in Ottawa, that a partial alternative to a national electricity grid may be the installation of coal pipelines, at least to some extent.

The possibility of pretreatment of Alberta coals (e.g. predrying or carbonization) was proposed as an interesting consideration, although the economics of pretreatment are still rather uncertain.

A suggestion was made that gas and oil injections in blast furnaces may reduce the coal and coke requirements of the steel industry. Mr. S.W. McDermott indicated that the Steel Co. of Canada has experimented mainly with gas injections, with excellent results. However there are indications that coal in oil injections may be even better. Mr. W.C. Whittaker emphasized that there is still a large place for coal and coke in the steel industry, since a minimum of 1100 lbs. of coke per ton of hot metal is required at present and, in the Japanese steel industry so important for Canadian coal mines, the coke rates are in the order of 1300 lb/ton of metal. Quite

frequently it seems that obtaining a maximum output with available facilities is more important than achieving a larger economy of coal or coke. Mr. C.L. O'Brian then drew attention to the necessity of placing the requirement figures in proper perspective, with thermal power generation being a much larger potential consumer than steel making. It was also noted that even though less coal or coke is needed per ton of metal produced, the total coal requirements for steel-making are still increasing in a general long term trend, inasmuch as steel production increases. The estimates of coal demand in the future are very uncertain. There are numerous possible sources of energy. For instance, although with U.S. coal, the cost of energy may now be about 4 mills/KWH, it is expected that the cost of energy from nuclear sources may be similar in 20 years from now. In 1985, it is estimated that from 18 to 25 million tons of coal per year may be required in Ontario.

To a question on possible difficulties due to cold weather affecting a coal-in-water pipeline, the Council's staff answered that they did not consider this problem as very serious, although they did not have any significant data on the subject.

Regarding difficulties of separating very fine coal from oil or water, Dr. Berkowitz mentioned Dr. J. Visman's work with cyclones, at the Department of Mines and Technical Surveys laboratory in Edmonton. Miniclone separation was considered effective above a particle size of 5 microns. It was also indicated that the Council's investigations have not included any pipe larger than 2 inches in diameter, most of the work being done on pipes about one inch in diameter. The abrasion was considered negligible.

The delegate from Imperial Oil Ltd. confirmed this view that abrasion is not prohibitive for most particles of sufficiently small size, as shown in details by the experience of the NEYRPIC-SOGREAH laboratories in France, and also by the Cleveland Consolidated coal pipeline, where thinner pipe could be used than the one installed in expectation of heavy wear (initial difficulties were solved there by crushing the coal to a smaller size). Although the $500 million estimate for the cost of a pipeline was reasonable, the cost of scale-up operations as proposed by the Council was likely to be much higher than estimated (maybe the double). However a lot of research and technological work has already been done, e.g. for Consolidated Coal and Gilsonite pipelines, and at research stations such as Neyrpic; considerable information is available in the literature, and more could be available. Thus it may be that scale-up work in Alberta is not necessary, if advantage is taken of experience and facilities available elsewhere. In any case scale-up expenditures of 0.5% of the cost of the commercial project would not seem to be adequate.

b) Possibilities of bulk transport of grain by capsule pipeline

Dr. J.A. Anderson, of the Board of Grain Commissioners, Winnipeg, stated that approximately 60% of the grain exported from the Prairie provinces is shipped to the Lakehead area, and 40% to Vancouver. Thus grain, coming in relatively small lots from numerous sources widely spread geographically, is moved out to only two collecting points. There are six principal varieties of grain, which must be handled separately. The fragility of the proposed plastic packaging may cause great difficulties. Large pipes would be needed. As a carrier, oil may not be any worse than water. Mixed transportation (by truck, railways and pipelines) is not likely because of the high costs of handling grain.

It is expected that more grain and less flour is going to be exported in the future, because grain handling is easier and many importers want to mill the grain themselves.

To a question regarding the desirability of exporting from the Prairie provinces the water used as a carrier, it was answered that the amounts of water involved would be relatively small. Besides, oil may be used as the carrier.

A question was made concerning the possibilities of compressed air for pipelining. Some information was requested on any known examples of full scale capsule pipelines. The Council staff stated that the proposed capsules would be about 24 inches in diameter and 4 to 5 feet long.

Mr. F.E. Parkinson, of Lasalle Hydraulic Laboratories Ltd., Lasalle, P.Q., (a Canadian firm associated with the large French Company NEYRPIC-SOGREAH), then described various installations (designed by Sogreah) where solids are transported in pipelines either vertically or horizontally (See "Engineering Journal of the EIC, June 1961, Transportation of solids in Conduits, by E. Condolios, P. Couratin and E. Pariset, p. 62-7). Mr. Parkinson stated that abrasion may be quite important in some cases, e.g. in the transportation of coarse ashes, gravel, etc., and he mentioned that even a relatively high cost of 2.5 cents per ton per mile was acceptable for the transportation of minus 0.5 mm limestone for a cement plant on a 30 km distance in a difficult case.

c) Pipelines for heavy mineral products

Mr. G. Heffernan indicated that Sogreah had estimated the pipeline transportation costs of solids as low as 0.5 or 2/3 of a cent/ton/mile in some cases. In most cases for heavy mineral products, the pipeline costs should be compared with truck haulage, which often costs 3 cents/t/mile. Most of these materials must be ground for proper transportation by pipeline, by usually not much finer than for the required processing. Cannon ball transportation would be more attractive than slurry pipelining. It is proposed that iron ore from the Peace River area would be moved by water or oil pipelines. It is estimated that only 300 gallons of water per minute would move one million tons of coal per year. Limestone must be ground for pipeline transportation. Potash could also be considered.

d) Role of pipeline companies

Mr. T.S. Johnston, of Interprovincial Pipeline Company, felt that the pipeline companies would be favourable to the studies proposed by the Research Council of Alberta.

Mr. G. Wilton, of Mid-Continent Pipelines Ltd., raised the legal aspects of solids pipelining, since legislations apply mainly to hydrocarbons at present. It was then stated that a potash slurry or solution was not feasible, but that potash capsules could be considered.

e) Role of pipeline contractors

Mr. R. Paul, of Canadian Bechtel Ltd., was very favourable to the proposed investigations, but felt that the technological difficulties, generally left to be solved in future studies, should not be dismissed too lightly, as also had been previously observed by Mr. Parkinson. Serious problems had been solved before, for instance in the SOGREAH-NEYRPIC installation of short distance capsule pipelining of containers of radioactive materials in France. However for long distances, the by-passing of pumping stations by the capsules may be difficult and expensive to solve.

f) Role of the railways

Mr. R.A. Evans, of the CNR, said that, although only economic studies had been undertaken by the CNR up to now, it might not be very long before technical studies of pipelining of solids would be initiated. It is estimated that about 27% of CNR traffic could be transported by pipelines. The present studies have included literature surveys, field trips, and consultations. Generally speaking, it seems unsound to build a pipeline for solids

where a railway exists now. Virgin territory would be more attractive and maybe only for portions of the itinerary. Each case would have to be judged on its own merits, perhaps later with some experimenting. In the future, the railroads are expected to cut their costs to a considerable extent by streamlining their operations, e.g. by using very long integrated trains. However the railway companies generally feel that they are a transportation industry rather than merely railways, and, if pipelines for solids are cheaper or better, they will participate in that industry too.

Mr. R.H. Shackson, of the New York Central Railways stated that in the case of their most efficient operations they are already moving freight at costs as low as those estimated for pipelining of solids. He also confirmed that if pipelines are found to be competitive, they will join. However their problems were somewhat different, since their operations were largely contained within 1,000 miles.

g) The national point of view

Mr. M. Royer, member of the National Energy Board, indicated that the NEB was favourable to the consideration and study of any means of cheaper transportation of products, including energy supplies.

Mr. C.L. O'Brian, chairman of the D.C.B., said that he had already indicated earlier in the meeting that the Dominion Coal Board was favourable to the consideration of any cheaper or better transportation method for coal.

Agenda item 7: Consideration of development of field studies and/or other future action

Dr. R.E. Wissinger, of Alberta Phoenix Tube and Pipe Ltd., stated that his parent company the Phoenix firm in Western Germany had participated in research on pipelines for solids at the University of Stuttgart with a group of a dozen European companies. He therefore offered their services regarding experimental work already done or proposed for the future.

Mr. F.E. Parkinson, of Lasalle Hydraulic Laboratories, mentioned experience obtained by the NEYRPIC-SOGREAH firm associated to his company. For instance, he indicated that a feasibility study had shown that the transportation by pipeline of liquid sulphur from Lacq to Bayonne (about 60 miles) would be uneconomical, mainly because of the large number of pumps and auxiliary equipment required. However, the pipeline transportation of a sulphur slurry was shown to be technically and economically feasible on a 1.3 million tons/year basis.

Mr. A.J. Allman, of the Department of Mines of Alberta, gave a number of suggestions of modifications regarding the proposals of the Research Council of Alberta for scale-up investigations. They included: studies of larger diameter pipes, cold weather protection, simulated breaks, terrain problems, and corrosion difficulties.

Mr. J.E. Oberholtzer said that, as the annual budget of the Council was about one million dollars, the scale-up project could not receive much financial support from this source, but he felt that some provincial government support was likely to be granted to a co-operative project financed by the industry.

Mr. A. Hnatyshyn suggested that the Federal government could participate in the proposed investigations. It was alleged that some sizable government funds had been granted to economically dubious railroad projects.

Mr. M. Royer mentioned inquiries made by the NEB from Dr. Steacie of the National Research Council. There seems to be a possibility of cooperation or support of the NRC and other federal organizations for a solids pipeline project.

Mr. W.A. Lang stated that the Research Council of Alberta could provide scientific talent and experience, and that patents could be made available at least on a limited time basis.

Mr. F.H. Larson, of Canadian Industrial Gas Ltd., said they were favourable to the proposed scale-up work.

Mr. S.W. McDermott, of Premier Steel Company, proposed the appointment of a steering committee of representatives of the firms and organizations interested in the project.

Dr. H.W. Habgood suggested the formation of a joint company including industrial firms and the Research Council of Alberta to undertake the scale-up investigations.

Mr. E. Connelly, of Pembina Pipeline Company, emphasized that the industrial firms would want their interests to be protected, and suggested arrangements such as those established by his firm with the research station of the University of Colorado to carry on pipeline research.

Mr. A.G. Swanson proposed that the new federal funds, recently announced as available for industrial research in Canada, be considered for this project.

The meeting showed a general feeling favourable to the undertaking of further work on the pipelining of solids.

Dr. G.W. Hodgson said the proposed programme could extend on 5 years.

Mr. D.R. Elliott, of the Pulp and Paper Institute, mentioned successful pipeline transportation of their products.

Mr. F.J. Harquail proposed the purchase of knowledge from organizations experimented in the pipelining of solids, for instance in the USA.

Mr. T.S. Johnston repeated the proposal of appointing a Steering Committee to recommend the next steps regarding sources of funds, fields of studies, programmes.

Mr. J.E. Oberholtzer suggested that the delegates correspond later to indicate the reactions of their principals.

The meeting approved the appointment of a Steering Committee. Mr. F.J. Harquail nominated Mr. E. Connelly as chairman of that Committee. Then on open nominations from various delegates, without formal voting, the Steering Committee was formed as follows: E. Connelly, W.C. Whittaker, R.E. Wissinger, T.S. Johnston, R. Paul, G. Heffernan, S.W. McDermott, H.M. Romoff, and representatives to be appointed later from Imperial Oil Ltd., B.A. Oil Ltd., the grain industry and the Pulp and Paper industry. This Steering Committee will work in close cooperation with the Research Council of Alberta.

Concluding remarks:

This "Pipeline Development Discussion" was mainly an information meeting for the benefit of various interested firms, that could financially contribute to the scale-up investigations proposed by the Research Council of Alberta. The Council has yet only made small scale laboratory investigations, as observed by us during field trips to Edmonton in recent years, and also during a visit to the Council's laboratories on May 17th, when small models of cannon ball and capsule pipelines were seen in operation.

The writer of this report attended the Edmonton meeting as an observer for the Director of the Mines Branch, and therefore he did not take part in the discussion, except to give brief technical precisions on a few important questions, which otherwise seemed to go unanswered: e.g. protection facilities against cold weather by drainage of the bare sections on the gilsonite pipeline in Utah-Colorado, possibilities of pneumatic pipelines (widely used in mines but generally too costly), example of a large scale capsule pneumatic pipeline (the old network linking most of the post-offices in Paris for very quick deliveries of letters).

Another important question, on which it was decided not to intervene because of the possible psychological effect, was concerned with the cost of scale-up investigations. The representatives of Imperial Oil Ltd. and Lasalle Hydraulic Laboratories Ltd. questioned the Council's estimates of $220,000 to $720,000 as being far too low. Nobody at the meeting gave any other estimate of such costs, but it did not seem to be desirable at that stage for a Federal Government observer to mention the estimate of at least 2 million dollars, which appears to have been spent on research, including scale-up work up to actual pipeline construction, just for one specific 100-mile pipeline for one commodity only (Consolidated Coal Co., Cleveland). This figure was obtained both indirectly from field trip conversations and from S.T. Bonnington of the British Hydromechanics Research Association.

As was implied in the remarks of some of the better informed delegates at and around the meeting, it seems that arrangements could be attempted to obtain most of the scale-up technology knowledge required, from experienced organizations in the U.S.A., France, U.K., Germany or elsewhere. It would seem reasonable to expect these services to be purchased at a fraction of the cost of installation of the proposed new experimental research station.

On the other hand, pipeline research on a laboratory or pilot plant scale is extremely desirable and should continue to be strongly encouraged.

It should be noted that, contrary to some statements recently made, the transportation of solids by pipelines, either in air or water or even in capsules, is not a new development. A lot of experience is available from the mining, mechanical and chemical industries (pneumatic and hydraulic stowing, transportation of ores and tailings at the mines, dredging, hydraulic mining, ash disposal, handling of chemical materials, etc.)

Recent developments are mainly characterized by the distances, lifts and amounts involved, which are becoming much larger than in the past. The cost of solving the numerous technological or scale-up problems thus presented may be greatly reduced by using as much as possible the expensive research stations now available, rather than building new research stations, that would be used only for one or a limited number of projects, unless no reasonable arrangements could be made. It may be noted that the Lasalle Hydraulic Laboratories Ltd. have estimated at 20 to 30 thousand dollars the cost of each feasibility study that may be required. More comprehensive studies even under unusual and difficult conditions might be purchased at higher but still reasonable fees. No figures are yet available from other organizations, but it would seem advisable to investigate all possibilities in any country.

/ ph